DETAILED ACTION

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 8-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamoto (2002/0104477) in view of Wang (2004/0121085) and alternatively further in view of Matsuda (5,808,316).

Yamoto teaches a method of forming a SiN film on a substrate, the method comprising using an exothermic catalyst body to activate silane, ammonia, and hydrogen gases ([0148] and Fig. 1).

Yamoto therefore teaches a film-forming step of forming a SiN film using a catalyst body and the named gases, <u>but does not teach</u> forming a laminated film of multiple layers or surface treating each layer with treatment steps including hydrogen gas active species and active species of the gas containing nitrogen component.

Wang teaches a method of forming a SiN film, using various silane gases and ammonia [0016-0026]. Wang teaches that the deposited films may be treated with a nitrogen containing source gas (NH3) and/or a hydrogen gas after the deposition step [0033] in order to remove hydrogen ([0034], [0020]). The either one or both gases are applied to the SiN substrate after being contacted against a "hot wire" to activate the gas [0033]. Based on the language that *either or combinations* of the gases may be applied, the teachings suggest

embodiments wherein each gas would be applied (separately) to the film surface as an effective manner of treating the film to remove hydrogen. It would have been obvious to one of ordinary skill in the art at the time of the invention to apply multiple (i.e. separate) steps of applying one of each H2 and NH3 to the SiN surface based on Wang's teachings that either or both of the gases is operable for removing contaminants from deposited SiN.

It would have been obvious to one of ordinary skill in the art at the time of the invention to apply the post SiN deposition treatment steps, including the separate steps of treatment using the activated nitrogen containing gas and separately activated hydrogen gas, of Wang to the SiN deposition method of Yamoto, as the treatment steps would allow one to reduce the hydrogen content of the film, which is desirable per the teachings of Wang.

The combined teachings therefore suggest a film-forming step of forming a SiN film using a catalyst body and the named gases and surface treating the SiN film with treatment steps including hydrogen gas active species and active species of the gas containing nitrogen component, <u>but do not teach</u> forming a laminated film of multiple layers, wherein each layer is treated.

Wang further teaches that a 200A thick silicon nitride film is useful for 65 nm technology [0037] and that hydrogen radicals can penetrate less than 100 angstroms deep into the film [0035]. Therefore if film of 200A is required, i.e. as

for a 65nm technology node, multiple layers are deposited in order to achieve desired thickness.

It would be obvious to iteratively repeat the steps of deposition and surface treatments, as taught by Wang, so that a SiN film could be formed with effective removal of the hydrogen, when combining the catalytic CVD deposition method of Yamoto with the surface treatment process of Wang.

Wang teaches a thermal process in general (and not specifically a catalytic process). Examiner takes the position that one of ordinary skill would have an expectation of undesirable hydrogen content even with the silane precursor suggested by Yamoto, particularly in view of Wang's disclosure that a film deposited at "low temperature" (wherein the substrate is less than 550 C [0005-6]) is especially susceptible to poor film quality due to hydrogen level [0019] and Yamoto's suggestion that the catalytic method is a 'low temperature" method in that the substrate may be held around 350 C, for example. Nonetheless, the additional teachings of Matsuda are alternatively presented.

Matsuda teaches that silicon containing films may be formed using silane gases such as SIH4 or chlorine containing silane gases (col 5, lines 33-47).

In further view of Matsuda, it would have been obvious to one of ordinary skill in the art at the time of the invention to apply the use of any of the gases suggested by Matsuda in the catalytic-CVD method of Yamoto as one would expect to operably form a silicon-containing film using chlorine containing silane

gases based on Matsuda's suggestion that such gases are operable in such catalytic processes.

The arguments presented above over Yamoto in view of Wang would be applied as noted above – with the additional suggestion of applying the chlorine containing gases of Wang – and the added/alternative motivation of removing Cl from the deposited SiN film.

Regarding claims 8 and 9, it would be obvious to repeat the treatment steps to effect a usable film. the teachings of Wang are not particular limiting, particularly in view of an optional nitrogen containing gas treatment step as noted and the suggestion that either NH3 or H2 or combinations thereof are operable in removing contaminants. It is further noted that Wang teaches that the steps are result effective in reaching a desired level of contamination in the film [0034]. While paragraph [0034] suggests a continuation of the process to achieve a desired low level, the embodiments suggested by Wang's teaching of different and continued steps would be understood to include repeating of any of the described treatment steps to achieve such a goal.

Regarding claim 10, Wang teaches continuous formation of the film including treatment steps for a number of layers [0035, 0037].

Regarding claim 11, Yamoto teaches the discharge of the gases from the process chamber [00149] taught by Yamoto is a vacuum pump [0065].

Regarding claim 12, the nitrogen step adds nitrogen to the film and the hydrogen step depletes hydrogen (or chlorine) from the film.

Regarding claim 13, the combined teachings as presented above teach a final step of hydrogen or NH3 treatment – each of which include a film component.

Regarding claim 14, Wang teaches that specifically if HCD gas is use, an inert carrier gas such as nitrogen may be used for a deposition process [0025].

Examiner takes official notice that it would be known to use a carrier gas with any silicon source gas; as such, it would have been obvious to one of ordinary skill in the art at the time of the invention to apply the use of an inert / nitrogen gas along with the silicon source used in the deposition process.

Furthermore, particularly related to the application of Matsuda, the use of HCD gas is encompassed in the combined teachings as a Cl-containing silane gas.

Regarding claim 15, per the teachings above, the teachings would be applicable either to silane gas as the silane precursor or a chloride (i.e. halide) of silane, particularly in the case of the latter in the further view of Matsuda.

The teachings as described above also teach a hydride of N (i.e. NH3).

Regarding claim 16, the surface treatment gases taught by Wang are H2 and NH3, as described above.

Regarding claim 17, all limitations are taught as per above, see particularly claims 8, 13, 15 and 16.

Regarding claim 18, Wang teaches the viability of H2 and/or NH3 treatment steps, and, per examiner's position, a mix of various treatment steps using either or both of the gases. It would have been obvious to one of ordinary

skill in the art at the time of the invention to apply either of the H2 and/or the NH3 steps as a final step.

Response to Arguments

Applicant's arguments filed 03/18/2011 have been fully considered but they are not persuasive.

Examiner does not agree that the combined teachings of Wang and Yamoto do not teach “a surface treating step of surface-treating the thin film for each unit layer by the hydrogen gas active species; another surface treating step of surface treating the film for each unit layer by the active species of the gas containing nitrogen component” as argued on p9.

Wang teaches that applying H2 and/or NH3 gases activated by a hot wire are effective for removing hydrogen from a deposited film. One of ordinary skill would understand <u>that if either gas is operable</u>, one could effectively apply both – either in the same treatment step or in alternative treatment steps, the teachings are not so limited as to restrict the treatment steps.

It is particularly noted that applicants claims require an “active species of the gas containing the nitrogen component", therefore, even if Wang teaches the effectiveness of the H radical created by activation of NH3, the gas composition in regard to the active species meets the claim requirement.

Applicants state that paragraph [0033] is limited from teaching multiple steps of the hydrogen removal treatment (see pages 9-10 of arguments),

however examiner does not agree. As per [0033], Wang states that a treatment step may include a hydrogen containing gas, such as "ammonia (NH3) and hydrogen gas (H2) or combinations thereof". While examiner would agree that one of ordinary skill would understand that this initially means that one would use either one or a combination of the gases in a single step - one of ordinary skill could further comprehend the implicit teaching that if either of the gases may be applied in one step, either of the gases could be applied either alone or in a mixture in more than one steps. Interpretation of the statement should not be limited to excluding a "combination" of treatments each using either of the gases. The MPEP 2112 addresses the fact that implicit disclosure may be relied upon. The MPEP 2141.03 I. further addresses the level of ordinary skill – examiner maintains that the disclosure that multiple gases, used each in a radical-forming treatment process, may be employed, constitutes a teaching that to one of ordinary skill that each gas is operable in the process and the use of multiple steps would be understood to address the same described problem.

Wang is open to alternative/multiple treatment steps as described by Fig. 2, including optional treatment with NH3 as in step 210 (which examiner agrees is not explicitly taught as a radical step) as well as a treatment step using radicalized NH3 or H2 (step 212 per [0033]). The suggestion to use multiple steps of treating the deposited SiN film, including at least one step with ammonia, therefore *at least* negates any suggestion of teaching away from applying independent steps with NH3 and H2 radicals. Additionally, however, based on the fact that both the NH3 gas treatment of step 210 and the hydrogen radical

treatment, using either NH3 or H2 gases, are each for the purpose of removing hydrogen (see [0028] as well as 0033-34]), it would not be particularly novel to perform both NH3 and H2 treatment using radicals, either because of the description of step 210 or that of step 212. An NH3 treatment step would succeed in reducing a deposited film H content when the gas is applied using catalytic decomposition as described in [0033-34] or using the gas as in [0028].

Regarding applicants submission that paragraphs [0025] and [0028] are not relevant (p10 of arguments), examiner maintains the relevance of [0028] as described above, teaching a post-treatment of a deposited film. (It is also noted that it appears applicants have an errant reference to [0038] in the middle of the last paragraph on p10, treated as a reference to [0028]). Regarding the reference to [0025], examiner noted that [0025] is relevant in introducing NH3 as a source gas – the only weight that it holds is in clarifying that the NH3 may be employed as a post-treatment gas even when applied for the deposition process.

While examiner agrees that Wang explicitly teaches a process with an optional single NH3 treatment and a radical treatment using either H2 or NH3, one of ordinary skill understands that Wang more generally teaches that either of H2 and/or NH3 radical steps would be beneficial for the reasons of record.

Applicants argue dependent claims based on arguments over claim 8 and examiner will therefore not further argue those claim rejections beyond that noted above.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSEPH MILLER, JR whose telephone number is (571)270-5825. The examiner can normally be reached on Mon-Thurs, 7am-4pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks can be reached on (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JOSEPH MILLER JR/
Examiner, Art Unit 1715

/Timothy H Meeks/
Supervisory Patent Examiner, Art Unit 1715